8.—FORAMINIFERA AND A TUBICOLOUS WORM FROM THE PERMIAN OF THE NORTH-WEST DIVISION OF WESTERN AUSTRALIA.

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INTRODUCTION.

This paper presents the results of the examination of a number of rock samples and other material containing foraminifera from the Permian of the North-West Division of Western Australia. The specimens were collected by Mr. Henry Coley and Dr. C. Teichert and, with two exceptions which will be noted later, are all from beds forming part of the Wandagee Stage of Dr. H. G. Raggatt (1936) and later authors.

Foraminifera have not been previously recorded from beds of the Wandagee Stage and, at first glance, the hard, brownish, impure limestones and calcareous, fine-grained sandstones, in places highly ferruginous, from these beds appear unfavourable to their occurrence. Fortunately a collection of the larger fossils, presented to the Museum of the Victorian Mines Department in 1938 by Mr. Henry Coley, included a specimen on the weathered surface of which examples of a large foraminifer, now identified as *Hyperammina coleyi*, sp. nov., were recognised. Mr. Coley and Dr. Teichert afterwards forwarded many samples from which the foraminifera now described were obtained. The calcareous nature of the rock in most cases enables the sandy-shelled foraminifera, which constitute almost the whole of the fauna, to be freed from the surrounding matrix by immersing the sample in weak hydrochloric acid. The results of this treatment have been surprisingly successful, for, although the number of species is not large, the number, size and preservation of the specimens is remarkable. Other specimens were identified on the surface of those samples which could not be treated with acid and a number were obtained from weathered sandy shale. Twelve genera and fifteen species of foraminifera are recorded, of which twelve species are described as new. There is also what is believed to be a new tubicolous worm.

DESCRIPTION OF THE SAMPLES.

In a recent paper, Dr. Teichert (1939) has dealt with the stratigraphy of the Permo-Carboniferous sequence of the North-West Division of Western Australia. The sequence has been divided by Raggatt (1936) and others into the following stages, which are given in descending order:—

Wandagee Stage

Kennedy Stage.

Byro Stage.

Wooramel Stage.

Callytharra Stage.

Lyons Stage.

As a result of his work with Messrs. H. G. Higgins and E. Utting on the Wandagee beds, Dr. Teichert subdivides the Wandagee Stage as follows (from above) :—

Fenestella-Helicoprion beds.
Lamellibranch beds.
Calceolispongia-Strophalosia beds.
Calceolispongia-Aulosteges beds.
Lingula beds.

On the presence of the shark *Helicoprion* and the crinoid *Calceolispongia*, he suggests an Artinskian rather than a Uralian age for the beds.

In a later personal communication, dated 18th May, 1940, Dr. Teichert states that, on a visit to Wandagee Station in 1940, he found an horizon higher than any previously met with, with the result that the total thickness of the Wandagee beds is increased from the 2,000 feet given in his paper to approximately 2,500 feet. With the exceptions noted later, the samples examined by the writer were from the new horizon and from the *Calceolispongia* (the *C.-Strophalosia* and the *C.-Aulosteges* beds have not been differentiated) and the *Lingula* beds.

As a result of the study of a large quantity of material, it was found that each of these beds was characterised by the presence of certain species which occurred in practically every sample from that horizon. It is therefore not necessary to give particulars of more than some representative samples from each of the beds. Before dealing with these in detail, it may be stated that the residues left from the samples after treatment with hydrochloric acid consist almost wholly of foraminifera, ferruginous mud, fine angular quartz grains, and frequently numerous flakes of mica. Evidence that silicification of some of the calcareous fossils has occurred is provided by the presence of siliceous replacements of molluscan shells in the residues.

Uppermost beds (unnamed)—about 200 feet above *Fenestella* beds:—

(1) Highly ferruginous fine-grained sandstone from Nalbia Paddock, about 110 chains due east of Trig. Station, Wandagee Hill. (Coll. C. Teichert.)

Foraminifera—

Ammodiscus wandageeensis, sp. nov. common, exposed on weathered surface of rock.

(2) Highly ferruginous fine-grained sandstone from Coolkilyia Flat, approximately 1 mile south of Homestead-Garden Road and 1 mile east of Shed-Outcamp telephone line. (Coll. H. Coley.)

Foraminifera—

Ammodiscus wandageeensis, sp. nov. common, exposed on weathered surface of rock.

Calceolispongia beds.

(3) South of Minilya River. Light brown impure limestone, near top of *Calceolispongia-Aulosteges* beds. (Coll. C. Teichert.)

The residues after treatment with HCl consist principally of countless fragments of *Hyperammina coleyi*, sp. nov.

Foraminifera—

Hyperammina coleyi, sp. nov. abundant.
Hyperamminoides acicula, sp. nov. frequent.

(4) Minilya Road, Coolkilyia Flat, east limb of syncline north of Wandagee Hill. Light brown impure limestone. (Coll. C. Teichert.)

Foraminifera

Tolypammina undulata, sp. nov. very common.
Hyperammina coleyi, sp. nov. frequent.
Hyperamminoides acicula, sp. nov. very common.

(5) Burna Burna Paddock, Wandagee Station, on Wandagee-Mia Mia Road, about 3 miles in 231° 5′ from Burna Burna Hill. (Coll. C. Teichert.)

Dr. Teichert states that the rock (a light brown, dense, impure limestone) contains fragments of a species of *Calceolispongia* and remains of *Cleiothyridina* ?, from which he concludes an approximately Middle Wandagee age of the beds. He adds that the outcrop is quite isolated by major faults and is situated more than 10 miles north-east of the type area of the Wandagee beds (Wandagee Hill). The foraminifera include two species which have otherwise occurred only in the *Lingula* beds.

Foraminifera

Ammodiscus nitidus, sp. nov. frequent.
Tolypammina sp. rare.
Hyperammina coleyi, sp. nov. one broken example.
Hyperamminoides sp. a fragment.
Thurammina papillata H. B. Brady. rare.

Lingula beds.

(6) South side of Minilya River, near Coolkilyia Pool, Wandagee Station. Brown impure limestone. (Coll. H. Coley.)

This material is very rich in foraminifera and included a worm tube constructed of broken sponge spicules.

Foraminifera

Ammodiscus wandageeensis, sp. nov. very common.
Ammodiscus nitidus, sp. nov. frequent.
Glomospira adhaerens, sp. nov. frequent.
Tolypammina undulata, sp. nov. rare.
Hyperammina coleyi, sp. nov. common.
Hyperamminoides acicula, sp. nov. common.
Psammosphaera pusilla, sp. nov. rare.
Thurammina papillata H. B. Brady. rare.
Crithionina teicherti, sp. nov. rare.
Calcitornella stephensi (Howchin). rare.
Ammobaculites woolnoughi Crespin and Parr. rare.
Reophax subasper, sp. nov. rare.
Reophax tricameratus, sp. nov. rare.
Trochammina subobtusa, sp. nov. rare.

(7) Same locality as No. 6. Brown impure limestone. (Coll. C. Teichert.) Foraminifera are very common and include numerous perfectly-preserved examples of a new species of *Crithionina*.

Foraminifera—

Ammodiscus wandageeensis, sp. nov. common.
Ammodiscus nitidus, sp. nov. frequent.
Glomospira adhaerens, sp. nov. frequent.
Hyperammina coleyi, sp. nov. frequent.
Hyperamminoides acicula, sp. nov. frequent.
Crithionina teicherti, sp. nov. common.

(8) East of Coolkilyia Paddock. 865 links east of Teichert, Higgins and Utting's Station LII. traverse of 20th May, 1939. Brown impure limestone. (Coll. C. Teichert.) The foraminifera in this sample are nearly all large and very well preserved.

Foraminifera—

Ammodiscus nitidus, sp. nov. rare
Tolypammina sp. frequent.
Hyperammina coleyi, sp. nov. common.
Hyperammina (?) rudis, sp. nov. rare.
Hyperamminoides acicula, sp. nov. common.
Reophax subasper, sp. nov. rare

Probably from *Lingula* beds.

(9) Extreme south-east corner of Coolkilyia Paddock. (Coll. H. Coley.) These specimens differ from any of the others recorded in having naturally weathered out of sandy shales. They are generally fragmentary and distorted, as is so frequently the case when foraminifera are found in shales. The weathered material in which they occur is a cinnamon-coloured fine sand.

Foraminifera—

Ammodiscus wandageeensis, sp. nov. rare.
Tolypammina undulata, sp. nov. rare.
Hyperammina coleyi, sp. nov. frequent.
Hyperamminoides acicula, sp. nov. common (specimens usually flattened, or transversely ribbed through pressure).
Crithionina teicherti, sp. nov. frequent (specimens generally collapsed).
Reophax tricameratus, sp. nov. rare.

In view of their interest, the following specimens are also included, although they are from beds below the Wandagee Stage:—

(10) Brownish-green thin-bedded micaceous sandstone from sandstone outcrops in the Gascoyne River at Jimba Jimba Homestead. (Coll. C. Teichert.) Dr. Teichert states that this is older than the Wandagee series of the Minilya district and is placed by Raggatt (1936, p. 135) in the Byro.

Foraminifera—

Hyperamminoides acicula, sp. nov. 6 selected specimens.

(11) Ferruginous, finely-sandy shale from Gastropod horizon of Cundlego Series, about 1 mile west of Cundlego Well, Minilya River. (Coll. C. Teichert.)

Foraminifera—

Hyperamminoides, sp. cf. **acicula**, sp. nov. very rare fragments.

TABLE SHOWING SPECIES OF FORAMINIFERA OCCURRING IN BEDS OF THE WANDAGEE STAGE AND THEIR DISTRIBUTION.

(This is based on Samples Nos. 1–4 and 6–8.)

Species.	Uppermost (unnamed) horizon.	*Calceolispongia* beds.	*Lingula* beds.
Ammodiscus wandageeensis, sp. nov ...	×	—	×
Ammodiscus nitidus, sp. nov.	—	—	×
Glomospira adhaerens, sp. nov.	—	—	×
Tolypammina undulata, sp. nov.	—	×	×
Hyperammina coleyi, sp. nov.	—	×	×
Hyperammina (?) rudis, sp. nov. ...	—	—	×
Hyperamminoides acicula, sp. nov. ...	—	×	×
Psammosphaera pusilla, sp. nov.	—	—	×
Thurammina papillata H. B. Brady ...	—	—	×
Crithionina teicherti, sp. nov.	—	—	×
Calcitornella stephensi (Howchin)	—	—	×
Ammobaculites woolnoughi Crespin and Parr	—	—	×
Reophax subasper, sp. nov.	—	—	×
Reophax tricameratus, sp. nov.	—	—	×
Trochammina subobtusa, sp. nov. ...	—	—	×

The foraminifera, with the exception of *Calcitornella stephensi*, are all species constructing their shells of extraneous material, usually quartz grains, cemented together by the animal. As the species are nearly all new, a close com arison with faunas elsewhere is not possible. Two of the species, *Calcitornella stephensi* and *Ammobaculites woolnoughi*, have been described from the Permian of Eastern Australia. The genera, with the exception of *Hyperamminoides* and *Calcitornella*, all occur living at the present day. Cushman (1933, pp. 161, 81) states that *Calcitornella* occurs in the Pennsylvanian and the Permian, but that *Hyperamminoides* is known only from the Pennsylvanian. Cushman and Waters, however, described at least one species of *Hyperamminoides*, *H. glabra*, from the upper part of the Graham formation of Texas, U.S.A. Raggatt and Fletcher (1937, p. 179) state that, while this was originally placed in the Pennsylvanian, it is now, they understand, considered to be Lower Permian.

Arenaceous foraminiferal faunas of the type occurring in the Wandagee beds are in present day seas characteristic of cold water. The genus *Hyperammina*, which is so common at Wandagee, is as a Recent genus widely distributed, but is most abundantly represented in cool waters, the temperature of the water having more control than the depth. The related, but now extinct *Hyperamminoides* probably occurred under similar conditions. *Crithionina* is also particularly characteristic of cold water.

The impure limestones and calcareous fine-grained sandstones in which these and the other foraminifera occur in the Wandagee beds indicate seas of no great depth, so it can be assumed that they represent a cool, moderately-shallow water facies.

The types of the new species described and other figured specimens have been deposited in the collection of the Geology Department, University of Western Australia. Examples of most of the species will also be lodged in the

Commonwealth Palaeontological Collection, Canberra, the Western Australian Museum, Perth, the Heron-Allen and Earland Collection in the British Museum, the Cushman Collection, the New Zealand Geological Survey Museum, and in the writer's own collection.

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DESCRIPTION OF THE SPECIES.

Phylum PROTOZOA.

Order FORAMINIFERA.

FAMILY **AMMODISCIDAE.**

SUB-FAMILY **AMMODISCINAE.**

Genus **AMMODISCUS** Reuss, 1861.

Ammodiscus wandageeensis, sp. nov.

Plate II., fig. 1.

Test large, free, planospiral, composed of a small globular proloculus, followed by a long undivided tubular chamber closely coiled in a single plane, the tube fairly thick-walled, almost circular in section and slowly increasing in diameter as it lengthens ; number of whorls usually 6 or 7 ; spiral suture strongly depressed ; wall coarsely arenaceous with a rough surface and little visible cement : aperture formed by the rounded open end of the chamber.

Diameter of test usually about 6 mm. ; thickness, 0.6 mm.

Holotype from Sample 6 (*Lingula* beds).

The exceptionally large size of this species (6 mm.) makes it a conspicuous object wherever it occurs. Palaeozoic species of *Ammodiscus* are usually small and the writer is not acquainted with any other with a diameter of more than 1 mm. *A. wandageeensis* may be compared with *A. semiconstrictus*, var. *regularis* Waters, from the Pennsylvanian of Oklahoma and Texas, U.S.A. The American form is less than one-sixth of the size of the Western Australian species, which also differs in its use of broken sponge spicules with quartz sand to form its test, and in its proportionately smaller proloculus. It is seldom that species of *Ammodiscus* incorporate spicules in the shell wall, but in *A. wandageeensis* they form a large part of the material used. A peculiar feature of many of the specimens is that the spicules have been leached out leaving numbers of short cylindrical cavities in varying planes in the shell wall. The occurrence of siliceous replacements of molluscan shells has already been mentioned ; possibly the silicia was derived from these spicules.

Ammodiscus nitidus, sp. nov.

Plate I., figs. 1*a*, *b*.

Test small, free, planospiral, composed of a minute proloculus and an elongate tubular chamber, almost semi-circular in section and slowly increasing in diameter, often transversely ridged, number of whorls usually 7 or 8, each whorl overlapping to a considerable extent its precedessor ; spiral suture only slightly depressed ; wall thin for the genus, composed of very small quartz grains with little visible cement ; shell surface comparatively smooth ; aperture semicircular, formed by the open end of the tube.

Diameter of holotype, 0·6 mm. ; thickness, 0·1 mm.

Holotype from Sample 8 (*Lingula* beds).

There are over 50 specimens. The smoothly-finished, thin shell wall and constrictions in the tubular chamber have led to the suspicion that the specimens are siliceous replacements of a species of *Cornuspira* or *Spirillina.* The surface of the test, however, absorbs water readily when it is moistened and, in thin section, the shell wall is seen to include quartz grains of different sizes. Both of these characters indicate that the specimens are referable to the genus *Ammodiscus.*

The central portion of the shell of *A. nitidus* is very thin and is often broken away. In many specimens the tube is regularly constricted at close intervals, but the constrictions are so slight as to be only faintly visible. These features and the smoothly-finished surface of the test will enable the species to be distinguished from any other. *A. bradynus* (Spandel), as described and figured by Paalzow (1935, p. 29, pl. iii., figs. 5, 6) from the Upper Permian (Zechstein) of Germany is perhaps nearest to *A. nitidus*, but the whorls do not overlap as in the Western Australian species.

Genus GLOMOSPIRA Rzehak, 1888.

Glomospira adhaerens, sp. nov.

Plate I., fig. 2.

Test usually attached, early portion coiled planospirally after which the tubular chamber increases in diameter and winds rather irregularly over the early portion to form a subglobular heap, finally in some specimens extending as a straight or curved tube adherent to the object of attachment ; wall composed of fine quartz grains firmly cemented to form a comparatively smooth surface ; aperture formed by the open end of the tube.

Diameter of closely coiled specimens up to 1·25 mm., with tube diameter of 0·25 mm. at end of tube.

Holotype from Sample 6 (*Lingula* beds).

Examples of this species are common in the material from the *Lingula* beds. They usually occur attached to the tests of *Hyperamminoides acicula*, but there are a few small free specimens. I have referred this species to the genus *Glomospira* as the plan of growth, except for the attached character of most of the specimens, is similar to that found in this genus. It may be added that the Recent *G. gordialis* (Jones and Parker), although typically a free form, occurs in the attached condition.

SUB-FAMILY **TOLYPAMMININAE.**

Genus **TOLYPAMMINA** Rhumbler, 1895.

Tolypammina undulata, sp. nov.

Plate II., fig. 2.

Test adherent, tubular, earliest portion apparently a small planospiral coil of about one whorl after which the tube winds from one side to the other or irregularly meanders over the object of attachment, the tube and the undulations meanwhile gradually increasing in size ; tube flattened on the under side ; wall formed of sand grains set in abundant cement ; surface comparatively smooth ; aperture formed by the open end of the tube.

Length up to 5 mm. or more ; diameter of tube at apertural end up to 0·4 mm.

Holotype from Sample 6 (*Lingula* beds).

Adherent tubular arenaceous foraminifera are very common in the middle and lower parts of the Wandagee Stage and the usual difficulty experienced in discriminating between these irregular-growing forms has been encountered. The present species may, however, be distinguished from the other tubular form described, *Glomospira adhaerens*, by the regular increase in the diameter of the tube as it lengthens and by the thicker tube wall, which is also more smoothly finished because of the much larger amount of cement used in its construction. Paalzow's *Adhaerentina permiana* (Paalzow, 1935, p. 29, pl. iii, fig. 3), from the Permian (Zechstein) of Germany, resembles the Wandagee species in form, but appears to differ in having the wall composed mainly of cement in which sand grains are embedded. *A. permiana*, according to Paalzow, was represented in his material by broken specimens only, the largest of which was over 2 mm. in length with a tube-diameter of 0·1 mm. It is therefore smaller and more slender than the present species.

FAMILY **HYPERAMMINIDAE.**

SUB-FAMILY **HYPERAMMININAE.**

Genus **HYPERAMMINA** H. B. Brady, 1878.

Hyperammina coleyi, sp. nov.

Plate II., fig. 3.

Test elongate cylindrical, consisting of a sub-globular proloculus and long slender tubular chamber of lesser diameter than the proloculus, widest in the middle portion, occasionally slightly constricted at irregular intervals ; wall thick, composed of medium-sized sand grains firmly cemented, surface rough, interior not smoothly finished ; aperture circular, formed by the open end of the tube.

Length up to 9 mm.; diameter of proloculus variable, ranging from 0·5 mm. to 1 mm.; diameter of tubular chamber usually about 0·5 mm.

Holotype from Sample 6 (*Lingula* beds).

This species is named in honor of Mr. Henry Coley, to whom the writer is indebted for so much interesting material from Wandagee Station.

Perfect examples of *H. coleyi* are common in the samples from the *Lingula* beds. Broken specimens, many of which are densely covered with *Tolypamminae*, occur in the *Calceolispongia* beds. The species may be compared with the Recent *H. elongata* H. B. Brady, from which it differs in the tapering apertural end, much thicker wall and rough interior. *H. bulbosa* Cushman and Waters (1927, p. 109, pl. xxii, figs. 7*a*, *b*), from the Pennsylvanian of Michigan, U.S.A., is also somewhat similar but has the proloculus flattened on one side and is much smaller.

Hyperammina (?) **rudis**, sp. nov.

Plate I., fig. 3.

Test elongate cylindrical, consisting of a tubular chamber closed at one end and of almost the same diameter throughout ; wall thick, composed of large angular to subangular sand grains firmly cemented ; surface very rough; aperture formed by the open end of the tube.

Length of holotype (probably incomplete), 1·4 mm.; breadth, 0·3 mm. Other specimens attain a slightly greater length.

Holotype from Sample 8 (*Lingula* beds).

There are fifteen examples, all from Sample 8. While one end of the tube of this species is closed, there is not a distinct proloculus and it is accordingly doubtful whether it is properly referable to *Hyperammina*. The very coarsely built test is unlike that found in typical *Hyperamminae* and strongly resembles that of *Rhabdammina*, in which genus, however, the end of the tube is not closed. It seems likely that a new genus of the Astrorhizidae is represented but the material available is not sufficiently well preserved to enable this to be decided.

Genus **HYPERAMMINOIDES** Cushman and Waters, 1928.

Hyperamminoides acicula, sp. nov.

Plate I., figs. 4, 5 ; Plate II., fig. 4.

Test elongate, tapering, sometimes at first slightly curved, very narrow at the initial end and from there gradually widening ; tube constricted at irregular intervals but not septate, the constrictions strongest in the early part of the shell ; wall thick, composed of comparatively small quartz grains set in abundant siliceous cement ; exterior smooth ; apertural end not constricted ; aperture circular, formed by the open end of the tube.

Length of holotype, 11 mm.; greatest diameter, 1·3 mm. Other broken specimens attain a diameter of 1·4 mm. or more and when complete were probably 18 to 20 mm. in length.

Holotype from Sample 7—brown, impure limestone, *Lingula* beds, south side of Minilya River, near Coolkilyia Pool, Wandagee Station (coll. C. Teichert).

The best examples of this fine species are from the *Lingula* beds in which it is common. The initial end of the larger specimens is in every case broken off. With these specimens, however, there are others of similar form, but very small and delicate, and it appears that these represent the early stages of the larger examples. Sometimes they are slightly curved in the earliest portion, but, with one exception, they are also incomplete. The exception, which is figured, shows a minute ovoid proloculus and is possibly the megalospheric form of the species. Another of these specimens, which is also figured with the same magnification, is extremely slender and apparently represents the microspheric form.

Several species of *Hyperamminoides* have been described from the Pennsylvanian of U.S.A. Of these, *H. proteus* (Cushman and Waters) described (Cushman and Waters, 1928, p. 36, pl. iv, figs. 5, 6) from Texas, most nearly resembles *H. acicula*, but has a different outline, particularly in the early stages, and attains a length of only 2·25 mm.

Prior to the receipt of the Wandagee material by the writer, Miss Irene Crespin, B.A., the Commonwealth Palaeontologist, had identified the genus *Hyperamminoides* in beds, probably of the same age as the Wandagee beds, in the Permian of New South Wales, and also in material collected by Dr. Arthur Wade and now in the collection of the Geology Department of the University of Western Australia, from the West Kimberley District, Grant Range, south section, just north of Hill 6. The Grant Range specimen has been kindly loaned to me and the species proves to be *H. acicula*. The examples of *Hyperamminoides* from New South Wales are from shales and are not sufficiently well preserved to enable a satisfactory specific determination. They have been recorded and figured, in a recent paper by Miss Crespin and the present writer (1941, p. 301, pl. xii, figs. 4, 5), as *H.* cf. *proteus* (Cushman and Waters). Better specimens may prove them to belong to the present species.

Dr. Teichert has forwarded six selected specimens of a species of *Hyperamminoides* in thin-bedded micaceous sandstone from beds of the Byro Stage on the Gascoyne River, at Jimba Jimba Homestead. These are referred to *H. acicula*. They are all broken and must have been of unusual size when complete, as one specimen in its present state is 16 mm. in length.

FAMILY **SACCAMMINIDAE**.

SUB-FAMILY **PSAMMOSPHAERINAE**.

Genus **PSAMMOSPHAERA** F. E. Schulze, 1875.

Psammosphaera pusilla, sp. nov.

Plate I., figs. 6, 7.

Test very small, spherical, consisting of a single chamber ; wall comparatively thick, formed of fine quartz grains, very firmly cemented, the cement apparently siliceous ; surface smoothly finished.

Diameter of holotype (an average specimen), 0·45 mm.

Holotype from Sample 6 (*Lingula* beds).

There are twelve examples of this species. The strength of the shell wall is, for such a small organism, remarkable. Considerable pressure with the point of a needle is necessary before the test can be broken.

P. cava, described by Moreman (1930, p. 48, pl. vi., fig. 12) from the Lower Palaeozoic of U.S.A., resembles the present species in external characters but has a thin wall ; its diameter is 0·5 mm. Moreman states that *P. cava* was very abundant in the Chimney Hill limestone. He remarks that it is very close to *P. papyracea* (Cushman), but that the latter has a thinner wall and is about twice as large.

Sub-Family SACCAMMININAE.

Genus THURAMMINA H. B. Brady, 1879.

Thurammina papillata H. B. Brady.

Plate I., fig. 8.

Thurammina papillata H. B. Brady, 1879, p. 45, pl. v., figs. 4–8 ; 1884, p. 321, pl. xxxvi., figs. 7–18. Chapman and Howchin, 1905, p. 9, pl. ii., fig. 13. Heron-Allen and Earland, 1917, pp. 530–537. Moreman, 1930, p. 51, pl. v., fig. 13.

Test spherical, consisting of a single undivided chamber ; wall thin, composed of sand grains firmly cemented ; apertures numerous and irregularly scattered over the surface, situated at the end of nipple-like projections.

Diameter of Permian specimens up to 0·6 mm. ; Recent, up to 1·5 mm.

The specimens are very well preserved, the internal cavity being unfilled and the apertures at the end of the surface papillae are still open. Palaeozoic examples of *Thurammina* seem to be more coarsely built generally than Recent specimens and also vary more in form than do the specimens found in any single Recent dredging. Heron-Allen and Earland (*loc. cit.*) have, however, shown that *T. papillata* varies considerably both in shape and in the size of the material used in the construction of the shell wall. The Wandagee specimens appear to fall within the limits of these variations and are accordingly referred to Brady's species.

One Wandagee specimen has the surface projections extended in the form of comparatively long tubes, at the end of which the apertures are situated. Brady has figured a similar Recent specimen in the Challenger Report (pl. xxxvi., fig. 14).

While *T. papillata* is best known as a Recent form, it has been recorded by Chapman and Howchin from the Permian of New South Wales and by Moreman from the Silurian of U.S.A.

Family ASTRORHIZIDAE.

Genus CRITHIONINA Goës, 1894.

Crithionina teicherti, sp. nov.

Plate I., figs. 9, 10.

Test free, comparatively large, spherical, thick-walled, but variable in this respect, central cavity large, connected with the outside surface by numerous moderately-sized pits which extend irregularly through the thickness of the shell wall and reach the exterior surface through minute openings ; wall composed of fine sandy material fairly well cemented, with a thin compact surface layer.

Diameter of holotype, 2·2 mm., other specimens are slightly larger.

Holotype from Sample 7 (*Lingula* beds).

As far as I am aware, there is only one previous record, that of Moreman from the Silurian of U.S.A., of this genus as a fossil. It is therefore specially interesting to meet with it in such numbers in the Permian of Australia. The specimens are exquisitely preserved and every detail of structure can be studied as readily as in the best Recent material.

In the living condition, *Crithionina* is best developed in cold waters, particularly in the North Atlantic, where it occurs in immense numbers.

FAMILY OPHTHALMIDIIDAE.

SUB-FAMILY CORNUSPIRINAE.

Genus **CALCITORNELLA** Cushman and Waters, 1928.

Calcitornella stephensi (Howchin).

Cornuspira, sp. nov. Jones, 1882, p. 6.

Nubecularia lucifuga Defrance, var. *stephensi* Howchin, 1894, p. 345, pl. x*a*, xi*a*.

N. stephensi Howchin: Chapman and Howchin, 1905, p. 5, pl. i., figs. 1, 2; pl. iii., figs. 13, 14; pl. iv., figs. 1, 4. Etheridge, Junr., 1907, p. 26, pl. x., figs. 4–9; 1907a, p. 13, pl. xii., fig. 11.

Calcitornella stephensi (Howchin): Chapman, Howchin, and Parr, 1934, p. 187.

No weathered-out examples of this species were found, the record being based on several internal casts found adherent to the tests of sandy species after the calcareous material in the rock had been dissolved by treatment with hydrochloric acid. The casts show the arrangement of the tubular chamber found in *C. stephensi*.

C. stephensi was described from the Permian of Tasmania and has since been recorded from beds of this epoch in New South Wales, Western Australia, and Northern Territory.

FAMILY LITUOLIDAE.

SUB-FAMILY HAPLOPHRAGMIINAE.

Genus **AMMOBACULITES** Cushman, 1910.

Ammobaculites woolnoughi Crespin and Parr.

Plate I., fig. 11.

Ammobaculites woolnoughi Crespin and Parr, 1941, p. 304, pl. xii., figs. 2, 3.

There are two specimens which appear to be referable to this species. The types are from the Permian, Farley Road, 300 yards north-east of Farley Railway Station, New South Wales. The Wandagee specimens, from the *Lingula* beds, are smaller (0·5 mm.) and built of coarser material than those from New South Wales, but are of similar form. The latter are from shales and this probably accounts for the finer-grained, more smoothly finished test.

FAMILY REOPHACIDAE.

SUB-FAMILY REOPHACINAE.

Genus **REOPHAX** Montfort, 1808.

Reophax subasper, sp. nov.

Plate I., fig. 12.

Test consisting of up to 7 chambers, rapidly increasing in size as added, early chambers indistinct, usually arranged in a curved series, later chambers larger and more distinct, in nearly a straight line; wall built of coarse quartz grains, firmly cemented, surface rough; aperture a small opening between three or more sand grains at the end of the final chamber.

Length of holotype, 1 mm.; breadth, 0·4 mm.

Holotype from Sample 8 (*Lingula* beds).

There are nineteen examples of this species. The most closely related Palaeozoic species is probably *R. asper* (Cushman and Waters, 1928, p. 37, pl. iv., fig. 7), from the Pennsylvanian of Texas, U.S.A. This is much like *R. subasper*, particularly when the specimens of the latter have lost the early arcuate series of chambers. The two may, however, be distinguished by the final chamber which in the Australian species is always wider than any other, while that in *R. asper* is narrower than the penultimate chamber.

Reophax tricameratus, sp. nov.

Plate I., fig. 13.

Test composed of a few (typically three) chambers, increasing rapidly in size as added, the last-formed chamber making up about half the length of the test ; axis of test straight or slightly curved ; wall composed of medium-sized sand grains, firmly cemented ; surface rough ; apertural end slightly produced ; aperture terminal.

Length of holotype, 1·7 mm. ; breadth, 1 mm.

Holotype from Sample 6 (*Lingula* beds).

This species is represented by the holotype from Sample 6 and six crushed specimens from the weathered shale sample (No. 9). It appears to be different from any previously-described form.

FAMILY **TROCHAMMINIDAE.**

SUB-FAMILY **TROCHAMMININAE.**

Genus **TROCHAMMINA** Parker and Jones, 1859.

Trochammina subobtusa, sp. nov.

Plate I., figs. 14*a*–*c*.

Test subglobose, trochoid, spire low, under side umbilicate, composed of three whorls ; chambers strongly inflated, with four in the last-formed whorl, the chambers of which are so much larger than those in the preceding whorls that they form the greater part of the test ; sutures distinct and depressed ; wall finely arenaceous, with the surface smoothly finished but not polished ; aperture an arched slit at the base of the last-formed chamber, opening into the umbilical depression.

Diameter of holotype, 0·45 mm. ; height, 0·24 mm.

Holotype from Sample 6 (*Lingula* beds).

This species is represented by six specimens, all of which are very well preserved. *Trochammina arenosa* Cushman and Waters (1927a, p. 152, pl. xxvii., figs. 4*a*–*c*), described from the Pennsylvanian of Texas, U.S.A., shows a similar arrangement of the chambers, but is much flattened and spreading and the wall is rather coarsely arenaceous.

Phylum ANNELIDA.
Class CHAETOPODA.
Sub-Class POLYCHAETA.

ORDER CRYPTOCEPHALA (SEDENTARIA OR TUBICOLA).

Amphictene (?) **permiana**, sp. nov.

Plate II., fig. 5.

Tube thin, circular in section, tapering slightly, formed of fragments of siliceous sponge spicules arranged concentrically in a single layer.

Length of holotype (incomplete specimen), 3·5 mm. ; diameter, 1·1 mm.

Holotype from Sample 6 (*Lingula* beds).

This species is represented by a single specimen. Its identification has been a matter of some difficulty, but after an examination of the available literature, it appears that it is a tubicolous worm, forming a tube like the Recent *Amphictene auricoma* (O. F. Müller). No foraminifer known constructs a similar test.

A. auricoma occurs in the North Atlantic and normally constructs its long, thin-walled, tapering, slightly curved tube of sand grains. On muddy bottoms (McIntosh, 1894 and 1922), broken sponge spicules are used instead of the sand grains, the spicule fragments being so arranged that those in one row alternate with those in the next, like the bonding of bricks in a wall, to form the strongest tube possible. A minimum of cement is used to hold the spicules together and the resultant tube is thin-walled and most neatly constructed and finished.

Nothing showing a wall structure like that found in the spicular tubes of *A. auricoma* appears to have been recorded as a fossil and the present specimen from the Permian is therefore of unusual interest. While it also consists of a similar layer of spicular fragments, comparison with the figures of *A. auricoma* given by McIntosh (*loc. cit.*) and by Heron-Allen and Earland (1909, pl. xxxv., fig. 14) and with examples of the Recent species for which I am indebted to my friend, Mr. Arthur Earland, F.R.M.S., shows the fossil form to be distinct, being less neatly built and also smaller than *A. auricoma*. It should be added that, while this comparison with *A. auricoma* has been made, the two forms may be unrelated although apparently similar ; the Permian species has accordingly been doubtfully referred to the genus *Amphictene*.

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EXPLANATION OF PLATES.

PLATE I.

Figs. 1*a*, 1*b*. **Ammodiscus nitidus**, sp. nov. Holotype. ×50. No. 20670.

Fig. 2. **Glomospira adhaerens**, sp. nov. Holotype. ×25. No. 20675.

Fig. 3. **Hyperammina (?) rudis**, sp. nov. Holotype. ×37. No. 20677.

Figs. 4, 5. **Hyperamminoides acicula**, sp. nov. Early stages, apparently of microspheric form (Fig. 4) and megalospheric form (Fig. 5). Both ×37. No. 20679.

Figs. 6, 7. **Psammosphaera pusilla**, sp. nov. 6, holotype external view; 7, internal aspect of another specimen. Both ×37. No. 20680.

Fig. 8. *Thurammina papillata* H. B. Brady. ×43. No. 20681.

Figs. 9, 10. **Crithionina teicherti**, sp. nov. 9, holotype, ×13; 10, internal aspect of broken specimen, showing wall structure, ×13. No. 20674.

Fig. 11. *Ammobaculites woolnoughi* Crespin and Parr. ×50. No. 20669.

Fig. 12. **Reophax subasper**, sp. nov. Holotype. ×37. No. 20685.

Fig. 13. **Reophax tricameratus**, sp. nov. Holotype. ×20. No. 20684.

Figs. 14*a*-14*c*. **Trochammina subobtusa**, sp. nov. Holotype. a, dorsal view; b, ventral view; c, edge view. All ×75. No. 20683.

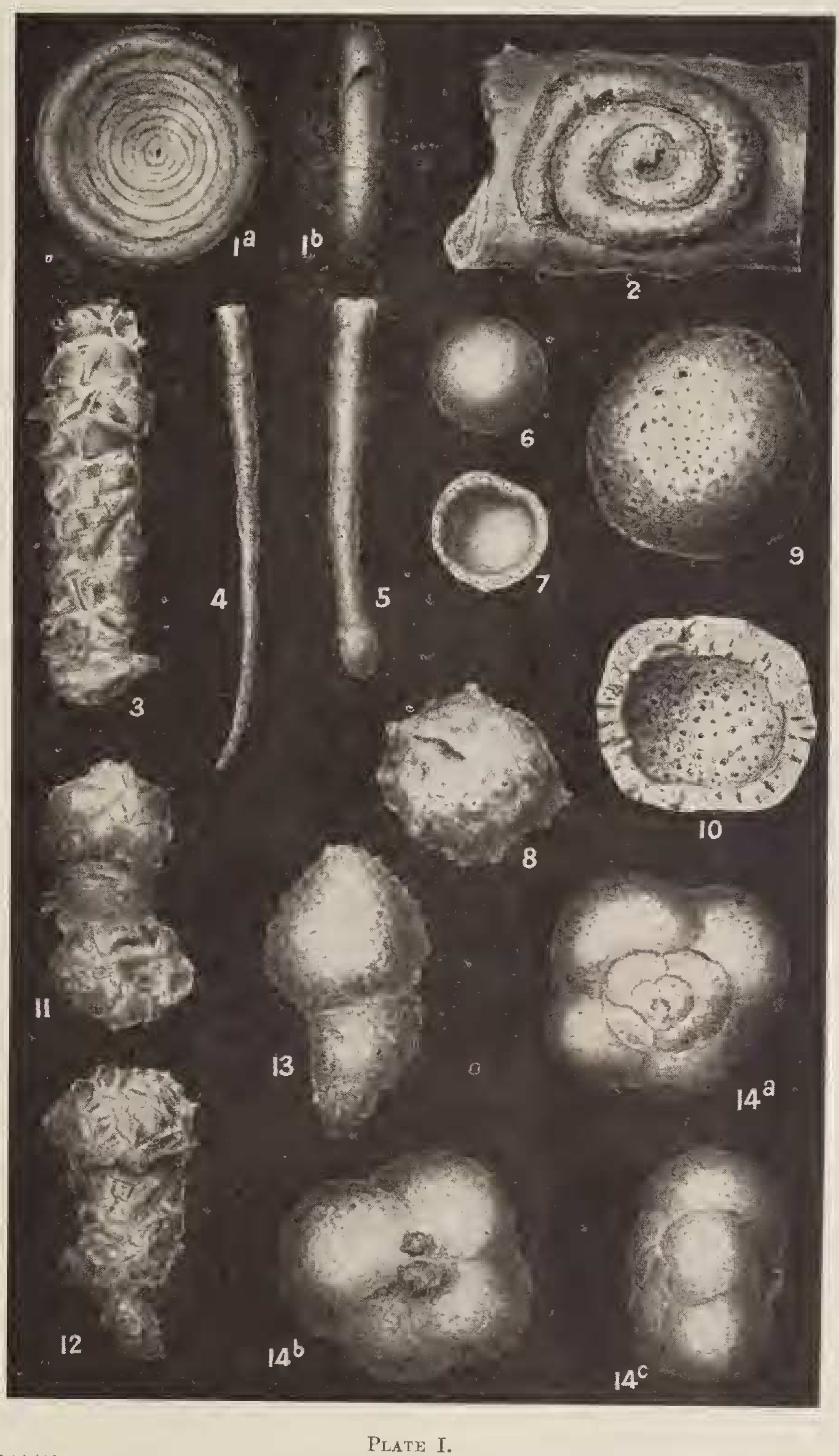

Plate I.

PLATE II.

Fig. 1. **Ammodiscus wandageeensis**, sp. nov. Holotype. ×12. No. 20671.

Fig. 2. **Tolypammina undulata**, sp. nov. Three specimens adherent to a test of **Ammodiscus wandageeensis**. The holotype is the specimen just to the right of the extreme left hand specimen. ×12. No. 20682.

Fig. 3. **Hyperammina coleyi**, sp. nov. Holotype. ×11. No. 20676.

Fig. 4. **Hyperamminoides acicula**, sp. nov. Holotype. $\times 9\frac{1}{2}$. No. 20678.

Fig. 5. **Amphictene** (?) **permiana**, sp. nov. Holotype. ×19. No. 20672.

Plate II.